Dental Size and Shape in the Roman Imperial Age: Two Examples From the Area of Rome

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ABSTRACT Different socioeconomic strata of Roman imperial age are represented by two large dental samples recovered from archaeological excavations near Rome, Italy. Teeth are investigated for crown dimensions and morphological variants. One sample, comprising 1,465 permanent teeth, represents the rural town of Lucus Feroniae (LFR) and is mainly composed of slaves and war veterans. The other, comprising 734 teeth from the Isola Sacra necropolis at Portus Romae (NIS), represents the "middle class" segment of an urban population. Both series show small dental dimensions and fit at the lower end of the trend toward dental reduction in Europe from the Upper Paleolithic to the historical times. The urban sample is less variable metrically and less sexually dimorphic than the rural one. The analysis of discrete crown traits shows absence of rare phenotypic variants in both series. The urban sample is also less variable in this last respect, suggesting that the gene pool of this particular "stratum" of the NIS population was more homogeneous than that of LFR. The occurrence of enamel hypoplasia indicates that metabolic stress during growth and development was similar in LFR and NIS. The overall set of available data is evaluated in the light of the history of the two Roman sites and the composition of each population. Am J Phys Anthropol 102:469–479, 1997.

Systematic examinations of dental samples of prehistoric and more recent Italian populations have been published in the last two decades (e.g., Passarello, 1976; Alciati et al., 1977; Coppa and Macchiarelli, 1982; Mallegni et al., 1984; Macchiarelli et al., 1988; Repetto et al., 1988); research on the structure of the teeth and the masticatory apparatus has been also developed on samples from this same country (e.g., Macchiarelli et al., 1991; Vargiu et al., 1993; various papers in Moggi-Cecchi, 1995). Until recently, however, dental variation regarding population samples of the Roman age (conventionally from the 5th century B.C. to the 5th century A.D.) has been little studied.

During the past decade, one of us (P.P.) coordinated the examination of two skeletal samples from necropolises of the Roman imperial period, from the rural village of Lucus Feroniae and from the town of Portus Romae (Isola Sacra necropolis), respectively, both referable to about the 2nd century A.D. Data were collected on the dentition (Santabarbara, 1987; Santandrea, 1994) and the associated skeletal material (Argenti and Manzi, 1988; Manzi and Sperduti, 1988; Manzi et al., 1987, 1989, 1991). Further research is scheduled for the near future, particularly on a new sample from Isola Sacra (Bondioli et al., 1995). Here, we consider dental size and shape of dental series

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from the two sites and combine these data with other sources of information already available.

Both necropolises were associated with towns that lay at no great distance from Rome (roughly 30 km in both instances) and had close links with the city that was at the center of the social and economic life of the empire. However, the two towns had very different histories and economies (Bartoccini, 1960; Testaguzza, 1970). One of these, the village of Lucus Feroniae, was an ancient commercial and religious center to the northeast of Rome. The other one, Portus Romae, came into being during the imperial period as the product of urban growth around Rome's main seaport at the mouth of the Tiber River. The archaeology of the associated burial grounds, the necropolis along the Via Capenate at Lucus Feroniae and the Isola Sacra necropolis between the cities of Portus and Ostia, also reveals a difference in social composition between the two case studies (Calza, 1940; Pellegrino, 1984; Baldassare et al., 1985; Gazzetti, 1986; Baldassare, 1987). In Isola Sacra, the epigraphic data, decoration, and monumental layout indicate that this particular skeletal sample represents an economically well-off "middle class" of artisans and tradesmen. Conversely, the type of grave used at Lucus Feroniae and the almost total absence of grave goods suggest that this necropolis was assigned to manual laborers of humble origin (slaves, freedmen, war veterans).

MATERIALS AND METHODS

The dental samples examined in this study include 1,465 permanent teeth from Lucus Feroniae (LFR), belonging to 112 individuals (43 males, 51 females and 18 of unknown sex) and 734 teeth from Portus Romae (NIS), referable to 64 adults (39 males, 22 females and 3 of unknown sex). Teeth with fractured or extremely worn crowns, widespread and destructive carious lesions, or dental calculus were omitted from the study. All others were measured and scored for discrete traits. Sex and age determinations were performed following the procedures of Acsádi and Nemeskéri (1970), Buikstra and Mielke (1985), Ferembach et al. (1979), Krogman and İsçan (1986). The examination of associated postcranial elements was frequently possible with the LFR material, whereas for the NIS sample, the determinations were carried out solely on the basis of cranial morphology, because depositional conditions made it impossible to reassemble the skeletons. Diagnoses of sex were made independently by two observers using the index introduced by Acsádi and Nemeskéri (1970). The two observers agreed in 92.8% of cases. When they did not agree, a third diagnosis was sought from another investigator and the majority opinion was adopted.

Mesio-distal (MD) and bucco-lingual (BL) crown diameters were measured to the nearest 0.1 mm independently by two observers, using digital calipers and the procedures described by Goose (1963). The mean of the two measurements was used unless the two differed by more than 0.5 mm, in which case a third measurement was obtained. Mean interobserver error was less than 6.5%. When both antimeres were present, the left and right values were averaged (Calcagno, 1986). Crown areas were calculated following Garn et al. (1977). Dimensional sexual dimorphism was assessed by Student's t-test (Kieser, 1990). Differences with $P < 0.05$ were considered statistically significant.

Nonmetric traits were recorded following the standard proposed by Turner et al. (1991), known also as the ASU (Arizona State University) system. The scoring was performed using plaster plaques representing the various gradations of expression of a single dental trait. Each trait was scored separately by two observers on both the antimeres. Cases of disagreement, which varied in frequency from 0% to 66.3% for various traits (cf., Nichol and Turner, 1986), were settled by seeking a third opinion. Presence/absence thresholds were defined following Turner (1987, 1990). Frequencies were calculated by the individual count method, i.e., considering only the antimere with the highest expression of the trait as the best expression of the genotype of the individual (Turner and Scott, 1977; Scott, 1980). The morphological diversity in the two Roman samples was evaluated using the chi-square test, with a significance level of 0.05, and compared with Iron Age Italian samples using factorial correspondence

TABLE 1. Male and female descriptive statistics in Lucus Feroniae (LFR)

	MD[1] diameter							BL[1] diameter							Areas						
	Males			Females				Males			Females				Males			Females			
	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	P[2]	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	P	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	P
Maxillary																					
I1	18	8.2	0.47	24	7.8	0.46	*	23	7.2	0.48	25	6.8	0.46	**							
I2	20	6.4	0.67	24	6.1	0.72		23	6.5	0.41	26	6.0	0.54	**							
C	21	7.5	0.46	30	7.1	0.45	**	23	8.4	0.58	31	7.9	0.43	**	21	62.8	7.74	30	56.1	5.52	**
P3	21	6.5	0.42	29	6.3	0.37		25	8.9	0.46	32	8.5	0.52	*	21	57.3	5.75	29	53.8	5.76	*
P4	23	6.3	0.48	27	6.1	0.45		27	9.1	0.53	29	8.6	0.60	**	23	58.2	6.86	27	52.6	6.62	**
M1	17	9.9	0.66	32	9.5	1.12		22	11.3	0.61	34	10.5	1.26	**	17	112.1	12.41	32	101.1	18.12	*
M2	23	9.2	0.63	32	8.7	0.76	**	24	11.4	0.74	33	10.8	0.74	**	23	105.5	11.36	32	93.7	11.33	**
M3	20	8.3	0.84	23	8.2	0.77		20	11.0	0.85	23	10.0	1.38	**	20	90.7	13.34	23	81.8	17.37	
Mandibular																					
I1	16	5.0	0.42	21	4.9	0.36		24	5.9	0.39	27	5.6	0.44	**							
I2	16	5.6	0.43	26	5.4	0.44		24	6.3	0.59	32	6.0	0.43	*							
C	26	6.4	0.44	36	6.1	0.43	**	32	7.7	0.62	38	7.3	0.49	**	26	49.2	6.52	36	44.7	5.80	**
P3	23	6.4	0.40	39	6.3	0.46		30	7.7	0.54	44	7.3	0.43	*	23	48.5	5.41	39	46.1	5.39	
P4	23	6.7	0.40	37	6.5	0.49		28	8.0	0.45	45	7.8	0.53		23	53.9	5.23	37	50.5	6.00	*
M1	22	10.7	0.47	31	10.4	0.66	*	31	10.4	0.39	36	10.1	0.48	**	22	112.2	8.69	31	104.2	10.24	**
M2	31	10.4	0.61	36	9.9	0.71	**	34	10.0	0.46	38	9.6	0.56	**	31	103.9	9.67	36	95.6	11.59	**
M3	29	10.2	0.79	25	9.8	0.85	*	28	9.8	0.44	25	9.3	0.61	**	28	100.8	10.01	25	91.2	13.31	**

[1] Mesio-distal (MD) and bucco-lingual (BL) crown diameters (in mm), and crown areas (in mm^2) mean values and standard deviations are reported.
[2] The column "P" shows the statistical significance (t-test) for each comparison between sexes: * $P \leq 0.05$; ** $P \leq 0.01$.

analysis (software SPAD.N, version 1.2; Lambert, 1986).

RESULTS

Morphometric analysis

Descriptive statistics of crown diameters and areas are reported in Tables 1–3. Most of the significant differences between LFR and NIS involve the mandibular dentition (27.3% of the variables, vs. 4.5% in the maxillary teeth). The LFR teeth are smaller than those from NIS in 75% of the metric variables, including all the statistically significant differences. This relationship is reversed if we consider only the male sample. Most (68.2%) of the dental dimensions are greater in LFR males than in NIS males. The opposite condition is observed in the female material (65.9% of the variables larger in NIS than in LFR). The differences between the two population samples are therefore mainly due to their respective female components. However, significant differences between the samples of each sex are observed only for two variables, i.e., the BL diameter of the upper second molar (M2) between males and the MD diameter of the lower canine (C) between females.

The LFR sample is more variable overall than NIS. The most variable teeth in size (crown area) are the upper third molar (M3; CV = 20.68 in LFR and 20.19 in NIS) and the mandibular C (CV = 14.80 in LFR and 17.75 in NIS) in both the samples, whereas the most dimensionally stable are the upper first premolar (P3; CV = 11.18) and the lower first molar (M1; CV = 9.98) in LFR and the upper and the lower M1 (CV = 9.46 and 7.46, respectively) in NIS. Variability is greater among the females in both samples. Sexual dimorphism is more evident in the LFR sample, in which most of the diameters and areas differ significantly between males and females. As expected (Garn et al., 1966), the upper C is the most dimorphic tooth, particularly for the BL diameter and in LFR, and BL dimensions tend to be more dimorphic than MD dimensions.

Morphological analysis

The percentage frequencies of 25 morphological variants of the upper and lower dentitions (69 tooth-trait combinations) are reported in Table 4. Since all the traits examined showed no significant sexual dimorphism (compare Turner et al., 1991), data from both sexes are pooled, and each series is considered as a single unit without regard to sex. The results obtained show that the two Roman samples are rather homogeneous in terms of dental morphology, as demonstrated by the completely nonsig-

TABLE 2. Male and female descriptive statistics in Portus, Isola Sacra (NIS)

	MD[1] diameter							BL[1] diameter							Areas						
	Males			Females				Males			Females				Males			Females			
	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	*P*[2]	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	*P*	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	*P*
Maxillary																					
I1	9	8.1	0.47	5	8.3	0.41		12	7.0	0.37	7	7.2	0.54								
I2	14	6.4	0.52	9	6.4	0.66		19	6.3	0.43	10	6.2	0.57								
C	23	7.4	0.34	14	7.2	0.53		30	8.2	0.63	15	7.8	0.55	*	23	61.2	6.06	13	54.7	6.30	**
P3	24	6.6	0.35	16	6.4	0.45		31	8.8	0.47	18	8.4	0.49	**	24	58.7	5.08	16	53.9	5.51	**
P4	23	6.3	0.42	14	6.2	0.76		28	9.1	0.46	16	8.5	0.71	**	22	58.1	5.90	14	52.5	9.08	*
M1	17	10.1	0.48	18	9.9	0.56		19	11.1	0.63	19	10.8	0.63		17	112.5	10.64	18	106.8	10.05	
M2	19	9.2	0.44	16	9.0	0.88		20	10.8	0.83	16	10.6	0.79		18	98.0	10.80	16	95.0	13.09	
M3	18	8.2	0.71	11	8.4	1.57		18	10.5	0.98	11	9.5	1.76		17	85.7	12.96	11	81.5	23.56	
Mandibular																					
I1	10	5.3	0.36	2	5.1	0.11		17	5.8	0.34	3	5.5	0.35								
I2	15	5.8	0.35	6	5.8	0.25		20	6.1	0.45	6	5.9	0.22								
C	17	6.4	0.40	6	6.7	0.73		21	7.6	0.76	7	7.4	0.88		16	48.3	7.55	6	50.2	11.88	
P3	23	6.6	0.42	9	6.4	0.38		27	7.5	0.48	9	7.5	0.61		23	50.2	5.58	9	48.3	6.28	
P4	25	6.7	0.40	8	6.4	0.27	*	26	8.1	0.42	8	7.7	0.79		24	54.5	4.86	8	48.7	6.80	*
M1	20	10.8	0.52	9	10.5	0.38		22	10.4	0.39	10	10.1	0.67		20	113.2	7.91	9	105.5	6.65	*
M2	26	10.2	0.54	11	10.0	0.55		27	10.1	0.52	11	10.0	0.84		26	102.9	9.50	11	99.7	10.38	
M3	25	10.2	0.68	10	9.8	1.22		25	9.7	0.51	10	9.4	0.91		25	98.6	10.81	10	91.9	15.23	

[1] Mesio-distal (MD) and bucco-lingual[1] (BL) crown diameters (in mm), and crown areas (in mm^2) mean values and standard deviations are reported.
[2] The column "*P*" shows the statistical significance (t-test) for each comparison between sexes: * $P \leq 0.05$; ** $P \leq 0.01$.

TABLE 3. Sex-pooled descriptive statistics in Lucus Feroniae (LFR) and Portus, Isola Sacra (NIS)

	MD[1] diameter							BL[1] diameter							Areas						
	LFR			NIS				LFR			NIS				LFR			NIS			
	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	*P*[2]	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	*P*	N	$\bar{x}$	S.D.	N	$\bar{x}$	S.D.	*P*
Maxillary																					
I1	49	7.9	0.52	15	8.2	0.43		56	6.9	0.49	20	7.1	0.42								
I2	50	6.2	0.71	24	6.4	0.60		55	6.2	0.52	30	6.3	0.49								
C	58	7.2	0.46	37	7.3	0.43		61	8.1	0.63	45	8.0	0.63		58	58.5	7.50	36	58.9	6.83	
P3	58	6.4	0.41	41	6.6	0.40	**	65	8.7	0.54	50	8.6	0.52		58	55.1	6.17	41	56.9	5.70	
P4	55	6.2	0.62	39	6.3	0.56		62	8.9	0.66	46	8.9	0.62		55	55.4	9.08	38	55.9	7.49	
M1	57	9.7	0.94	37	10.0	0.51		64	10.8	1.06	40	10.9	0.64		57	105.3	16.19	37	109.4	10.34	
M2	63	8.9	0.72	37	9.1	0.66		65	11.0	0.80	38	10.7	0.79		63	98.0	12.52	36	96.3	11.54	
M3	49	8.2	0.93	31	8.3	1.06		49	10.3	1.36	31	10.1	1.35		49	84.9	17.57	30	84.4	17.05	
Mandibular																					
I1	44	4.9	0.36	12	5.2	0.33	**	59	5.7	0.45	20	5.7	0.35								
I2	53	5.5	0.43	21	5.8	0.32	**	68	6.1	0.51	26	6.1	0.41								
C	73	6.2	0.47	23	6.5	0.50	**	80	7.4	0.62	28	7.5	0.78		72	45.8	6.77	22	48.8	8.66	
P3	73	6.3	0.47	32	6.5	0.41	**	85	7.4	0.50	36	7.5	0.51		73	46.8	5.84	32	49.7	5.75	*
P4	69	6.6	0.61	33	6.6	0.40		81	7.9	0.52	34	8.0	0.55		68	52.2	7.58	32	53.1	5.87	
M1	66	10.5	0.63	30	10.7	0.48		80	10.2	0.49	33	10.3	0.52		66	106.9	10.68	30	110.6	8.25	
M2	79	10.1	0.70	38	10.1	0.54		84	9.8	0.56	39	10.0	0.62	*	79	98.9	11.64	38	101.7	9.73	
M3	59	10.1	0.88	35	10.1	0.86		58	9.6	0.59	35	9.6	0.65		58	96.9	13.30	35	96.7	12.39	

[1] Mesio-distal (MD) and bucco-lingual[1] (BL) crown diameters (in mm), and crown areas (in mm^2) mean values and standard deviations are reported.
[2] The column "*P*" shows the statistical significance (t-test) for each comparison between sexes: * $P \leq 0.05$; ** $P \leq 0.01$.

nificant results obtained through the chi-square analysis.

In view of their similarity (see Fig. 2), the LFR and NIS data were pooled to furnish a morphological profile of the imperial Roman population as a whole, which is as follows.

In the maxillary dentition, labial convexity is not present on the incisors, and double-shoveling occurs on the central incisor (I1) at a low frequency (7.89%). The presence of double-shoveling and absence of labial convexity is in accordance with the hypothesis that these two traits are inversely correlated (Nichol et al., 1984; Turner et al., 1991). The "Etruscan upper lateral" trait (Pinto-Cisternas et al., 1995) frequently appears on the lateral incisor (I2; 25.64%). Peg-shaped lateral incisors are quite rare

TABLE 4. Discrete dental traits in Lucus Feroniae (LFR) and Portus, Isola Sacra (NIS)

	Tooth-trait combination	LFR N	LFR %	NIS N	NIS %	Pooled data N	Pooled data %
Maxillary							
1	I1 Labial convexity	24	0.00	8	0.00	32	0.00
2	I1 Shoveling	24	8.33	4	25.00	28	10.71
3	I2	19	26.32	9	33.33	28	28.57
4	I1 Double-shoveling	28	10.71	10	0.00	38	7.89
5	I2	34	0.00	16	0.00	50	0.00
6	I1 Interruption groove	38	34.21	16	37.50	54	35.19
7	I2	41	53.66	16	75.00	57	59.65
8	I2 "Etruscan upper lateral"	51	27.45	27	22.22	78	25.64
9	I1 Tuberculum dentale	36	75.00	15	60.00	51	70.59
10	I2	39	84.62	23	91.30	62	87.10
11	C	50	60.00	37	72.97	87	65.52
12	C Mesial ridge	46	0.00	26	0.00	72	0.00
13	C Distal accessory ridge	18	55.56	7	57.14	25	56.00
14	P3 Cusp number	49	4.08	39	0.00	88	2.27
15	P4	37	0.00	25	0.00	62	0.00
16	M1 Hypocone	63	100.00	39	100.00	102	100.00
17	M2	56	78.57	33	81.82	89	79.78
18	M3	37	67.57	26	53.85	63	61.90
19	M1 Cusp 5	43	2.33	26	7.69	69	4.35
20	M2	46	17.39	25	20.00	71	18.31
21	M3	36	16.67	23	34.78	59	23.73
22	M1 Carabelli	37	29.73	27	18.52	64	25.00
23	M2	54	5.56	28	7.14	82	6.10
24	M3	39	10.26	29	17.24	68	13.24
25	M1 Parastyle	47	4.26	27	11.11	74	6.76
26	M2	65	0.00	39	0.00	104	0.00
27	M3	44	2.27	29	0.00	73	1.37
28	I2 Peg-shaped	58	1.72	33	0.00	91	1.10
29	M3	52	1.92	31	0.00	83	1.20
30	M3 Congenital absence	63	7.94	52	0.00	115	4.35
31	C Root number	38	0.00	19	0.00	57	0.00
32	P3 Root number	29	34.48	8	62.50	37	40.54
33	P4	29	3.45	15	6.67	44	4.55
34	M1 Root number	20	100.00	6	100.00	26	100.00
35	M2	22	90.91	8	100.00	30	93.33
36	M3	24	45.83	8	37.50	32	43.75
Mandibular							
37	I1 Shoveling	22	0.00	4	0.00	26	0.00
38	I2	38	5.26	15	0.00	53	3.77
39	C Distal accessory ridge	36	11.11	11	9.09	47	10.64
40	P3 Lingual cusp	74	5.41	33	15.15	107	8.41
41	P4	57	12.28	27	22.22	84	15.48
42	M1 Anterior fovea	12	75.00	1	100.00	13	76.92
43	M1 Deflecting wrinkle	34	2.94	11	0.00	45	2.22
44	M1 Distal trigonid crest	39	0.00	13	0.00	52	0.00
45	M1 Y groove pattern	44	75.00	21	90.48	65	80.00
	X groove pattern		18.18		4.76	52	13.84
46	M2 Y groove pattern	75	22.67	35	25.71	110	23.64
	X groove pattern		57.33		60.00	110	58.18
47	M3 Y groove pattern	50	16.00	32	12.50	82	14.63
	X groove pattern		78.00		81.25	82	79.26
48	M1 Cusp number	62	90.32	27	96.30	89	92.13
49	M2	78	10.26	32	15.62	110	11.82
50	M3	52	38.46	32	65.62	54	48.81
51	M1 Protostylid	46	2.17	19	0.00	65	1.54
52	M2	58	10.34	25	12.00	83	10.84
53	M3	41	53.66	26	38.46	67	47.76
54	M1 Cusp 5	59	86.44	25	96.00	84	89.29
55	M2	78	6.41	32	9.38	110	7.27
56	M3	50	32.00	32	50.00	82	39.02
57	M1 Cusp 6	58	0.00	24	0.00	82	0.00
58	M2	77	0.00	33	0.00	110	0.00
59	M3	50	6.00	30	0.00	80	3.75
60	M1 Cusp 7	65	4.62	30	0.00	95	3.16
61	M2	78	2.56	34	0.00	112	1.79
62	M3	51	0.00	31	0.00	82	0.00
63	M3 Congenital absence	86	17.44	40	7.50	136	14.29
64	C Root number	40	0.00	12	0.00	52	0.00
65	P3 Root number	36	0.00	13	0.00	49	0.00
66	P4	36	0.00	12	0.00	48	0.00
67	M1 Root number	27	100.00	1	100.00	28	100.00
68	M2	27	88.89	3	66.67	30	86.67
69	M3	31	74.19	5	80.00	36	75.00

(1.10%). Both shoveling and the interruption groove show increasing frequencies from I1 (respectively, 10.71% and 35.19%) to I2 (respectively, 28.71% and 59.65%); so does *the tuberculum dentale* (70.59% and 87.1%), which occurs at lower frequencies in C (65.52%). The upper canines also show high frequencies of the distal accessory ridge (56%). Premolar mesial and distal accessory cusps are rarely present on P3 (2.27%), and are absent on the second premolar (P4). Two roots are rare on P4 (4.55%), but frequently present on P3 (40.54%), the key site for root number variation (Turner, 1981). On the maxillary molars, the frequency of hypocone occurrence decreases from M1 to M3 (respectively, 100%, 79.78% and 61.9%). Conversely, frequencies of the metaconule increase from M1 to M3 (respectively, 4.35%, 18.31% and 23.73%), contrary to expectations (Harris and Bailit, 1980). Carabelli's trait occurs more frequently on M1 and M3 (respectively, 25% and 13.24%). A parastyle occurs at low frequencies on M1 (6.76%) and on M3 (1.37%). Peg-shaped molars and congenital absence of upper M3 are rarely present (respectively, 1.20% and 4.35%).

In the lower dentition, shoveling of incisors and distal accessory ridge of C are quite rare. Premolar lingual cusp variation is uncommon; the lower P4, which is considered the key site for this trait (Turner et al., 1991), is the most variable of the premolars (15.48%). In the mandibular molars, the highest frequency of the Y groove pattern (metaconid and hypoconid in contact) is on M1 (80.00%); lower M2 and lower M3 exhibit greater frequencies of the X groove pattern (protoconid and entoconid in contact; 58.18% and 79.26%, respectively). Conversely, the protostylid is seldom observed on M1 (1.54%), but its frequency increases from lower M2 (10.84%) to lower M3 (47.76%). More than 4 cusps are almost always present on lower M1 (92.13%), far less frequent on lower M2 (11.82%), and moderately frequent on lower M3 (48.81%). The entoconulid (cusp 6), the metaconulid (cusp 7), and the deflecting wrinkle are quite rare. Lower M3 is congenitally absent in 14.29% of all mandibles.

DISCUSSION

The data presented here provide a basis for characterizing dental variation in Italian populations of the Roman imperial age. The principal findings are: the presence of small dental dimensions in both samples, a dimensional variability greater in LFR than in NIS, including higher levels of sexual dimorphism, and the absence of rare phenotypic variants in both samples.

The small dental dimensions of the two Roman samples are apparent in Figure 1, where data on LFR and NIS are plotted against those from other European and Italian populations ranging in time from the Upper Paleolithic to the Iron Age. The graph shows the well-known trend toward reduction in dental size among human populations (Smith, 1977; Frayer, 1984; Macchiarelli and Bondioli, 1986b; Brace et al., 1987; Calcagno, 1986, 1989; Calcagno and Gibson, 1988, 1991). Between the two extremes (EUP and LFR), more than 20% of the occlusal surface from maxillary P4 to M2 is lost. A dramatic decrease is observed at the Mesolithic-Neolithic transition, probably reflecting gene flow, if not the arrival in Europe of waves of agriculturalist immigrants from the Levant (Ammermann and Cavalli-Sforza, 1984). Subsequently, Bronze and Iron Age dentitions show a great amount of diversity between populations. This pattern could reflect different adaptations to various environmental conditions, as well as microregional differences in genetic balance between the gene pools of earlier and more recent immigrants.

The LFR and NIS samples fit the lower end of the reduction trend illustrated by the plot in Figure 1. Since imperial Roman populations (particularly the LFR sample) would be expected to be more variable genetically than their predecessors, it can be hypothesized that their position was conditioned by environmental more than genetic factors, for instance, by adaptive responses to new life conditions (e.g., Calcagno, 1989), or by increased population density and its related effects (Macchiarelli and Bondioli, 1986b; compare Gibson and Calcagno, 1989).

It is known that metabolic disturbances during growth and development can reduce

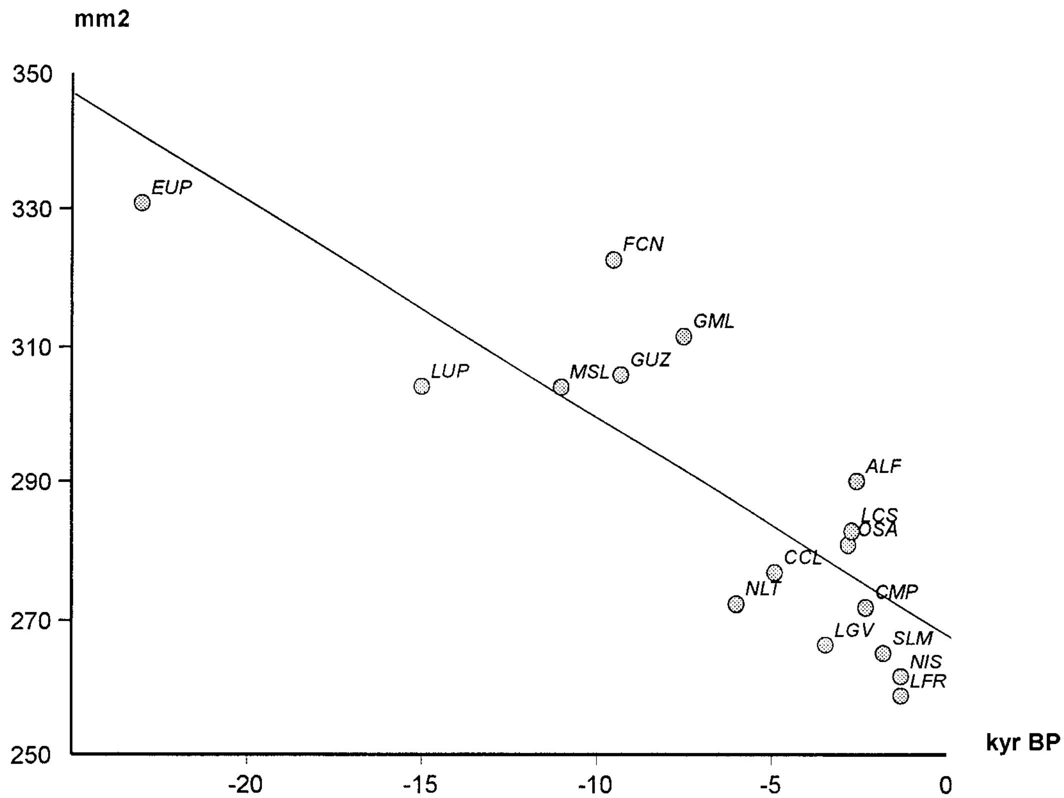

Fig. 1. Summed crown mean areas from maxillary P4 to M2 (values in square millimeters) in samples from Upper Paleolithic to Roman imperial age, ordered according to their respective chronological horizon. A best-fit line is also indicated. Comparative data are taken from Alciati et al. (1977), Frayer (1978), Coppa and Macchiarelli (1982), Borgogni Tarli and Repetto (1985), Macchiarelli and Bondioli (1986a), Manzi and Salvadei (unpublished data). Samples in chronological order: EUP, Early Upper Paleolithic European sample (n = 14 to 24 depending on the type of tooth); LUP, Late Upper Paleolithic European sample (n = 14–24); MSL, Mesolithic European sample (n = 78–98); FCN, Fucino (Mesolithic; n = 2–6); GUZ, Uzzo Cave (Mesolithic; n = 6–10); GML, Molara Cave (Mesolithic; n = 1–2); NLT, Neolithic European sample (n = 43–46); CCL, Cala Colombo (Neolithic; n = 7–8); LGV, Luogovivo, Pulsano (Bronze Age; n = 3–10); OSA, Osteria dell'Osa (Iron Age; n = 15–22); LCS, Le Castagne (Iron Age; n = 12–13); ALF, Alfedena (Iron Age; n = 91–101); CMP, Campovalano (Iron Age; n = 15–18); SLM, Sulmona (late Iron Age; n = 13–16); NIS, Portus (Roman imperial age; n = 36–38); LFR, Lucus Feroniae (Roman imperial age; n = 55–63).

gene expressivity for dental dimensions (Garn et al., 1979; Guagliardo, 1982). Following y'Edynak (1989), we tentatively suggest a possible relationship between dental dimensions and occurrence of stress markers in LFR and NIS. Linear enamel hypoplasia (arrested or reduced amelogenesis) was previously recorded in the same Roman samples and combined with data concerning presence and dating of Harris lines (arrested or reduced bone growth; Manzi et al., 1989). An extension of the analysis is at present under way (Salvadei, 1995; Salvadei et al., 1995).

These studies show that both markers consistently affected the two population with slight differences between them; concerning enamel hypoplasia, for instance, the individual incidence in LFR is 82.0% and in NIS 81.0%. Males are significatively more affected by enamel hypoplasia than females in both samples (compare Tanner, 1988; Van Gerven et al., 1995). Therefore, according to the common interpretation of this kind of evidence (e.g., Goodman and Rose, 1991), the occurrence of systemic stress during tooth and bone development in the urban

and middle class population of NIS is comparable to that in the rural and slave LFR community. Such an unexpected result can be related to the effects of higher population density (recurring famine episodes, spread of epidemic diseases, etc.) in the urban sample than in the rural one. For the latter, we can hypothesize the consequences on growth and development of indigent conditions which probably characterized that population segment. Thus, though any causal interpretation of this composite evidence is largely speculative at present, the data presented here suggest a possible correlation between environmental stress and dental dimensions. From this perspective, the lower sexual dimorphism observed in NIS should be better considered as an expression of adaptive responses to environmental stress (Brace and Ryan, 1980; Relethford and Hodges, 1985), rather than as an indicator of genetic diversity between NIS and LFR.

From another point of view, however, the higher variability observed in LFR for dental size is in accordance with the results reached in previous comparisons of cranial size and shape between the same samples (Argenti and Manzi, 1988; Manzi and Sperduti, 1988), as well as with the variability observed for the postcranial morphometrics in LFR (Salomone, 1990). The population of NIS appears also more homogeneous than LFR in terms of dental morphology, according to the presence of peaks of expression for some variants which characterize the former sample (cf. Table 4: traits n. 7, 21, 32, 45, 50, 56). This evidence appears consistent with the known ancient importance of Lucus Feroniae as a commercial and religious center, before its stable "colonization" during the Roman empire, and also with the inferred assignment of this particular necropolis to manual laborers of diverse ethnic provenience.

Regarding morphological dental variation, an exploratory comparison was made possible by a research project aimed to obtain large series of nonmetric (ASU) data on teeth of Italian populations of the 1st Millenium B.C. (Coppa et al., 1995). One of the preliminary results of this attempt (Colafranceschi, 1994) produced a set of data useful for our comparison with discrete crown variation in the Roman age. A correspondence analysis was performed using 40 discrete dental traits recorded for LFR, NIS, and groups of pre-Roman (Iron Age) population samples: Appenninians, Campanians, Picenians, and Samnites. In this analysis (Fig. 2), the first three axes involved 82.3% of the total variability, more than 75% of which was concentrated in the first two axes. Combining the relative distributions along the 1st and the 2nd axes, the Roman samples cluster together, whereas a major divergence between LFR and NIS is observable along the 3rd axis. The Iron Age samples are widely displaced from the Roman samples along the 1st axis, but differ markedly from each other along the 2nd and the 3rd axes. The Appenninians seem to segregate from the other samples, consistently with their geographic isolation in the mountain habitat of central Italy. The Samnites and the Picenians show more affinities with LFR than with NIS, in accordance with the ancient link of Lucus Feroniae with internal paths of communication before the Roman "colonization."

To summarize, the critical evaluation of dental size and shape variables collected in this study is consistent with the history of the two Roman sites and the hypotheses about the composition of each population. These can be seen, in turn, as a secondary consequence of genetic admixture due to the opening of gene flow pathways during both pre-Roman periods (e.g., Etruscans, Greek colonies; compare Piazza et al., 1988) and the military and political expansion of Rome across the Mediterraneum. Furthermore, the characterization of the two samples with respect to Iron Age populations of central Italy is in accordance with the similarity observed in the direct comparison between them. The differences between the two Roman samples support the hypothesis that the gene pool of the population segment represented here by NIS (the "middle class" inhabitants of the town of Portus) was more homogeneous than that of the LFR rural sample, mainly composed of slaves and war veterans. Both samples, however, show indications of metabolic stress suffered by most of the individuals during growth and development, without a clear connection with

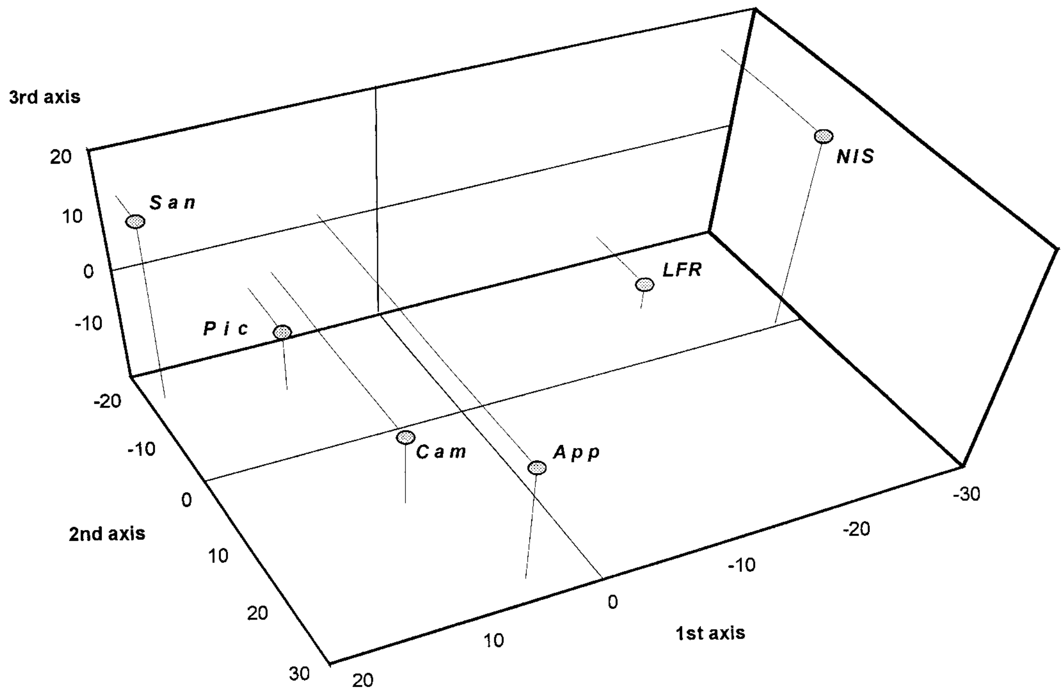

Fig. 2. Correspondence analysis for a subset of the ASU traits used in the present study (traits 2, 3, 6–8, 11, 13, 17–27, 30, 32, 35, 36, 39, 43, 45–47, 49–53, 55, 56, 60–63, 68, 69) for Iron Age samples from south-central Italy in comparison with LFR and NIS. The three axes represent, respectively, 37.82%, 29.00%, and 15.53% of the total variability. Comparative data from Colafranceschi (1994): Pic, Picenians (samples from Campovalano, Colle Quinzio, La Cona, Marchesa Sant'Egidio, Nocciano; n = 275); San, Samnites (samples from Alfedena and Pennapiedimonte; n = 143); App, internal sites along the Appennines (samples from Caporciano, Le Castagne, Scurcola; n = 36); Cam, sites from Campania, south-western Italy (samples from Sala Consilina and San Marzano; n = 79); LFR, Lucus Feroniae (n = 112); NIS, Portus (Isola Sacra necropolis; n = 64).

their respective social extraction and different life conditions.

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